Interaction experiments between eucritic glass and 0.1 M NaCl aqueous solution at 300-500°C and 1.5 kbar: Suggestions on water-rock interactions at the bottom of Europa’s subsurface ocean

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Europa, the second satellite of Jupiter, probably has subsurface ocean under its icy crust. The yellow-brown color of its leading anti-Jovian hemisphere could be explained by endogenous substances such as sodium chloride, which suggests the presence of hydrothermal activity (water-rock interaction) [Hand and Carlson, 2015]. In this study, we conducted water-rock interaction experiments to determine the mineral assemblage of altered rock on Europa’s mantle surface and to constrain the amount of available energy for sustaining the putative chemoautotroph-based ecosystems.

In our experiments, eucritic synthesis glass and 0.1 M NaCl aqueous solution were reacted at 300-500°C and 1.5 kbar for 8, 16 and 32 days, using cold-seal type pressure vessels. The water/rock mass ratio was fixed at 1/1 in all the experiments (50 mg of powdered glass to 50 μL of NaCl solution). Solid products were analyzed by X-ray diffractometer and SEM equipped with EDS. Water chemistry of the reacted solution were determined by ICP-MS.

The mineral assemblages observed in our experiments were as follows.

- Fe-rich smectite (saponite), epistilbite and xonotlite at 300°C and 1.5 kbar
- Fe-rich smectite (saponite), ferroactinolite, Ca-rich plagioclase and minor amount of magnetite at 400°C and 1.5 kbar
- Mg-rich smectite, ferroactinolite, Ca-rich plagioclase, magnetite and hydroxyapatite at 500°C and 1.5 kbar

The formation of magnetite at 400-500°C suggests that these high-temperature water-rock interactions may generate hydrogen and sustain chemoautotroph-based ecosystems. As a future work, we would like to evaluate the hydrogen generation potential quantitatively.